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Period Drift in a Neutrally Stable Stochastic Oscillator

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Periodic oscillations are observed in biology and ecology across multiple scales from individual cells to the population level. Traditional models based on differential equations are useful for analyzing oscillating systems. However, when discrete population stochastic effects substantially influence the system dynamics on the timescales of interest, alternative representations are required. We apply a hierarchy of approaches from discrete stochastic to differential equations to study a neutrally stable stochastic oscillator model. Using differential equations, the model features a conserved quantity that remains constant over the periodic orbit. When stochastic effects are considered, the system deviates from the deterministic orbit, leading to noise in the period and deterministic conserved quantity and, eventually, extinction. We quantify how the period drift and the time to extinction scales with the population of the system. Finally, we discuss the benefits, limitations and computational expense of the numerical methods that coincide with the various modeling approaches.